Proceedings World Geothermal Congress 2015
Melbourne, Australia, 19-25 April 2015

Environmental Audit Score-Card for Menengai Geothermal Project, Kenya: 2011-2013

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Keywords: Environmental audits, Environmental Management Plan, Environmental compliance.

ABSTRACT

The Menengai geothermal drilling project follows the No Objection Environmental and Social Impact Assessment (ESIA) of 2007. The Environmental Management and Coordination Act of 1999 (EMCA 1999) cascades from international environmental legislation and requires annual environmental audits for projects stated in the second schedule. The primary objective is to check compliance and conformity to the Environmental Management Plan (EMP) realized from ESIA studies. Not only do the Audits satisfy national legislation against environmental litigation and liabilities, but also donor requirements which require assurance on project sustainability with respect to environmental impacts and public acceptance.

The Geothermal Development Company limited (GDC) is currently developing the Menengai geothermal field through government and donor support. The project's medium term goal is development of the field in phases to a capacity of 460 MWe by the year 2016. To ensure continuous improvement with respect to sustainable development and realize the intended plans, the company schedules annual external environmental audits and quarterly internal environmental audits. This paper presents a qualitative and quantitative environmental measure of environmental impacts arising from Menengai's project activities stemming from exploratory to production drilling with respect to EMP compliance. Key environmental impacts arising from project activities in various areas of operation, such as infrastructural works and drilling processes, are evaluated against key environmental performance indicators with set targets for appraisal during environmental audits. Based on the findings, improvement orders are designed for issue to specific departments. The systematic approach can also be applicable to other geothermal projects. The process is intended to raise environmental awareness and evaluate and improve environmental performance and compliance in geothermal development.

1. INTRODUCTION

The Government of Kenya plans to transform the country into a newly industrialized middle-income economy by the year 2030 (RoK, 2007). To achieve this, accelerated development of the energy sector is quite critical. With the current energy demand of about 1354 MW_e against an effective supply capacity of 1532 MW_e (Kenya Power, 2013), there is an urgent and prioritized need to hasten deployment of clean and reliable energy projects. Due to its intrinsic stability and environmental benefits compared to hydropower and fossil energy, geothermal energy development has been earmarked as the best alternative. With the establishment of the Geothermal Development Company limited, proven resources in excess of 10,000 MW_e along the Kenya rift valley are in plans for development with the delivery of 5000 MW_e by the year 2030. Presently 311.61 MW_e and 15 MW_t is generated from geothermal resources within the Olkaria and Eburru fields. These projects are managed by the Kenya Electricity Generating Company Limited (KenGen). Oserian Development Company Limited (ODCL) and Ormat technologies have satisfied key environmental requirements and are located within conservation areas, such as the Olkaria projects within the Hells Gate National Park and Eburru well-head power plant within the Eburru forest. The KenGen projects are partly government and donor funded, while the Ormat Olkaria IV and ODCL projects are fully private.

Development of the Menengai geothermal field commenced in 2010; after fully-fledged Environmental Impact Assessment (EIA) studies and approval in 2007 by the National Environmental Management Authority (NEMA). This was based on geo-scientific indications of a geothermal resource in excess of 1,600 MW_e (RoK, 2011). Menengai follows as the third geothermal field under government and donor development after Olkaria and Eburru in Kenya, with medium term plans underway to deliver in phases 460 MW_e by the year 2016. Cascading from International, bilateral/multilateral and national legislation such as the US NEPA (1970), World Bank safeguards and others EIA has been adopted as a mandatory requirement to balance the three tenets of sustainable development: the economy, society and environment (Ogola, 2008). This process employs holistic and systematic evaluations/analyses to identify and predict all socio-economic and environmental impacts of proposed projects. The ultimate goal is to ensure decisions and activities of proposed projects are environmentally sustainable. According to the Environmental Management and Co-ordination Act (EMCA, 1999) and its second schedule, drilling of wells for geothermal energy development must undergo EIA studies (RoK, 1999). A succeeding Environmental Audit (EA) is further compulsory on an annual basis for projects to ensure compliance and conformity to the statements of the EIA and the Environmental Management Plan (RoK, 1999).

According to the Environmental Impact Assessment and Audit regulations of Kenya (2003), Environmental Audit (EA) entails a systematic documentation, periodic and objective evaluation of activities and processes of an ongoing project. The aim is to establish whether proponents are complying with environmental requirements approved in the management plan and legislation enforcement. EA further ensures compliance to the project's internal environmental policy, raises environmental awareness/management, promotes public participation/acceptance of projects, enforces corrective action/improvement on non-conformities and strengthens financial/donor support confidence toward project sustainability (Ogola, 2008). The impetus is to promote a safe and healthy environment at all stages of project operations and decommissioning.

This paper focuses on the environmental performance of geothermal activities within the Menengai Caldera based on Regulatory Compliance and Environmental Management Plan Audits. The scope is delimited to exploratory, appraisal and production drilling. The results are evaluated annually for the period 2011 and 2013.

1.1 Regulatory Compliance and Environmental Management Plan Audits

Among the main conditions for donor or fund agencies to commit on geothermal projects is the existence of qualified and able environment and community liaison departments to ensure projects' sustainability. The World Bank, for instance, influenced establishment of the Environment and community liaison staffing at KenGen's Olkaria project prior to funding in 1999 to manage, monitor and mitigate against any undesirable environmental impacts caused by the project.

Since its establishment in 2009, GDC has developed environment and community liaison departments comprising a multi-disciplinary group of professionals. The various disciplines cut across biology, ecology, bio-chemistry, analytical chemistry, natural resource management, forestry, eco-toxicology, community development, and others. These professionals are grouped into sections according to their expertise to undertake environmental monitoring as per the Menengai Environmental Management Plan (EMP). The sections include rehabilitation, afforestation and biodiversity conservation, waste management, air quality and meteorological monitoring, noise monitoring, waste water management, precipitation, soil and vegetation quality, and regulatory compliance. The community liaison department exists independently and deals with community development within the project.

The EMCA (1999) allows for registration of qualified environmental experts drawn from different environment related disciplines to perform an Environmental Impact Assessment and Audit (EIA/A) through the National Environment Management Authority (NEMA) of Kenya. These experts are certified as environmental inspectors under the ACT and are licensed to perform EIA/A on any land/premises or activity. GDC has therefore methodically trained its entire Environment staff both locally and internationally on the ESIA/A methods as required by the law. These staff is licensed to carry out EIA/A studies and subsequent environmental monitoring within its projects and especially the Menengai geothermal project.

Within the project, Environmental Management plan audits are comprehensively undertaken in tandem with regulatory compliance audits and are combined to an Environmental Audit. EMCA (1999) recognizes the need for an initial environmental audit and further internal and self-audits (external). Initial audits yield baseline information upon which subsequent environmental audits are based. Initiated by the regulatory compliance team, audits are scheduled quarterly as internal and an annual self-audit. The self-audit is submitted to NEMA for compliance monitoring and a certificate of conformity issued either deeming the operations safe and healthy or in the case of significant impacts, issues improvement notices. Internal audits are monitored within the project through the regulatory compliance team who issue improvement orders for non-conforming operations. The audits are carried out jointly by all the environmental experts within the department and have since covered all activities related to exploratory, appraisal and production drilling. During all self-audits, however, independent environmental consultants are engaged for synergy with the internal environmental experts. GDC flags this as important to avoid any form of bias and obtain independent assessment from external experts who are not involved in the daily project operations. An initial audit was also conducted in 2011. Routine internal and self-audits have been on-going since.

This paper will refer to exploratory, appraisal and production drilling as '*drilling*' henceforth since the environmental implications at each of the stages do not differ significantly as at times the same exploration wells serve as appraisal wells and may/will eventually function as production wells.

2. MENENGAI GEOTHERMAL PROJECT ACTIVITIES AND ENVIRONMENTAL ASPECTS

The Menengai geothermal project is located within the Eastern arm of the African Rift system on the outskirts of Nakuru Town, about 180 km northwest of Nairobi, Kenya (Figure 1). It covers approximately 2,183 km^2 in area.

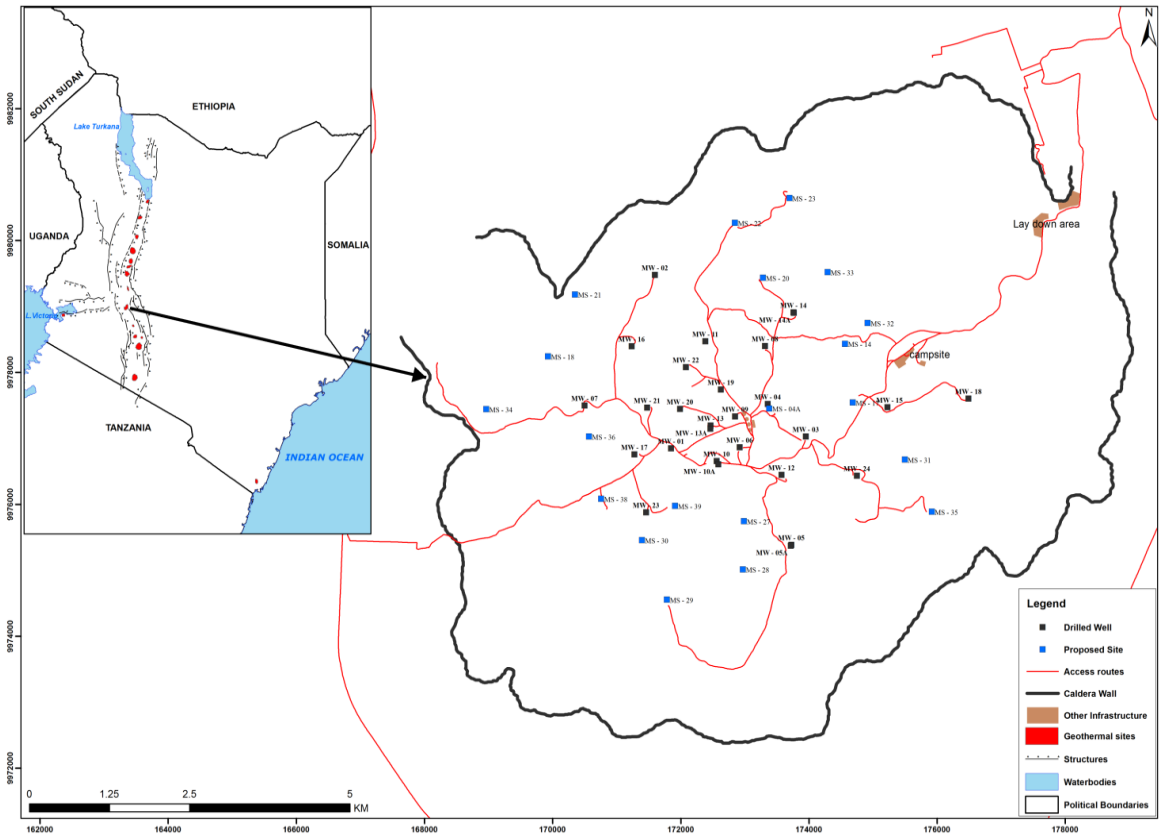

Figure 1: Location of the Menengai geothermal project in Kenya **(GDC GIS SECTION, 2014).**

2.1 Project Activities and Environmental Impacts

Marked a vision 2030 flagship project, the Menengai geothermal field entails step-wise development toward achievement of its near maximum sustainable potential over the next decades. Exploratory and production drilling has been ongoing with presently over 20 wells.

Since commencement, project activities have in summary entailed:

1. Land acquisition from the Kenya Forest Service (KFS) and private owners. Part of the land is owned by the government through KFS and private farmers. A Memorandum of Understanding (MoU) was jointly signed between GDC and KFS in 2011 on sustainable utilization of the Menengai Caldera and its resources (GDC and KFS, 2011). All affected farmers have been fully and satisfactorily compensated according to the prevailing market rates.

2. Infrastructural site works - preparation of access roads, water pipeline routes, well pads and brine disposal ponds.

3. Camp site establishment with a capacity of about 200 persons to-date.

4. Installation of water infrastructure including pipelines, tanks and lining of waste water ponds.

5. Drilling of 10 potable water boreholes inside the caldera and over 20 geothermal wells. Currently directional drilling of the first two (2) wells; MW 13A and MW 10A has since commenced and is on-going (GDC, 2014). The plan is to have a maximum of 5 wells per pad.

6. Installation of well-head and well-testing equipment. Part of the completed wells has and is still undergoing well discharge testing.

7. Tree nursery establishment for rehabilitation and social afforestation. Among its objectives, the environment department is keen on restoration of the Menengai environs which form part of the Mau forest, an important water tower in Kenya. The department sets an annual target of raising, planting and issuing 60,000 tree seedlings to farmers and institutions within the project.

Common negative environmental impacts and some remedial procedures include:

1. Soil erosion during preparation of access roads, water pipeline routes, well pads and brine disposal ponds sometimes leading to formation of small gulleys from storm water flows. Excavated soil during well-pad preparation is used in filling up the gulleys. Gabions have also been constructed along roadside areas. Indigenous grass and trees are also planted to hold the soil.

2. Solid and liquid waste generation. Generally, waste emanates from rig operations, the drillers camp, central workshop and storage yards. It mainly consists of plastic containers, cartons, scrap metals, bentonite sacks, paper, waste oil and other food/domestic refuse. A waste inventory has been developed to keep track of the amount and types of wastes generated for mitigation measures. A compost pit was constructed to turn all organic (food) waste into manure. The manure will be used at the tree nursery. This facility is yet to be operational. For the other wastes, a licensed waste handler was contracted to collect the waste on a daily basis. Other wastes such as drill cuttings are contained in the lined waste water ponds. Liquid waste generated is mainly separated water (brine) during well-testing. This water is contained in lined (high density plastic) waste water ponds, mixed with potable water and re-used for drilling. Future efforts will entail re-injection of the water. The ponds will also eventually be covered upon successful well testing and area rehabilitation.

3. Noise emissions, which are normally below 80 DB (A) as required by the Occupational Health and Safety Act of Kenya (2007). Cases which exceed 80 DB (A) occur during well testing and occasionally range between 90 - 100 DB (A) especially for dry wells. Staff working in these areas are provided with Personal Protective Equipment (PPE) which is worn all the time.

4. Hydrogen sulfide and trace element emissions (e.g. mercury, boron and arsenic) occur in gaseous or dissolved form during drilling and well-testing. The elements are transmitted via geothermal water sprays or drilling returns. Hydrogen sulfide poses an odor nuisance and is monitored using mounted and handheld detectors at the rig sites. Detectors will sound an alarm if levels exceed the WHO 10 ppm maximum allowable limits and staff are supposed to immediately evacuate from the area (WHO, 1981). Other gases monitored using a multi-gas detector include atmospheric Sulphur dioxide, Nitrogen monoxide, Chlorine, Nitrogen dioxide, Carbon monoxide and Mercury vapor which have overtime recorded low concentration.

5. Visual intrusion. With the introduction of a wide array of infrastructure and project activities, there is compromised aesthetic value to the natural environment, even though it leads to creation of an industrial park upon project completion. To counter this, all infrastructure is camouflaged to blend with the natural environment.

6. Potential contamination of surface and sub-surface water (boreholes), soil, waste water and vegetation quality. This is a rare occurrence and quarterly monitoring is carried out on chemical signatures associated with geothermal energy. Analyses are carried out at internationally accredited laboratories and there have been no documented cases of contamination within these matrices. Chemical analysis in waste water (brine) indicates levels beyond the wastewater quality criteria for surface disposal in any environment as recommended by the Environmental Management and Coordination (Water Quality) Regulations of 2006. This water is therefore contained in lined ponds for re-use during drilling and later re-injection to avoid potential soil and vegetation contamination.

7. Vegetation clearing during well-pad preparation and other associated infrastructure. Surveys are carried out before to establish existing vegetation for rehabilitation thereafter. Well-pads are maintained to a maximum area of 75 m x 150 m and are designed to contain 5 geothermal wells. Upon completion of a well, an environment report is prepared for every well and appropriate rehabilitation measures are undertaken.

3. ENVIRONMENTAL SCORE-CARD FOR THE YEARS 2011 – 2013

3.2 Methodology

The nature and scope of details in an environmental audit can be defined in different ways since there is no definite methodology provided by the law. Different approaches and techniques have been accepted and used for impact examination and presentation of results. This is vital as it suggests ways of improving project sustainability.

A qualitative and quantitative approach to audit key environmental impacts during geothermal drilling has been designed and tested in this study to assess environmental performance within Menengai's project between the years 2011 and 2013. The methodology is based on Kaplan and Norton's balanced score card (1996) framework. Impacts are categorically grouped as physical, biological and socio-economic aspects and weighed against Key Performance Indicators (KPI) and set annual targets. The KPI's and annual targets have been generated in this study based on the last environmental audit reports (FOMEC, 2011; Simiyu et al. 2012; GDC, 2014). Overall weights are based on the environmental aspects with the totals; physical aspects 33%, biological aspects 33% and socio-economic aspects 34%. All the aspects add up to 100% interpreted as 100% compliance. The aspects were given the same weights as it was difficult to compute which aspect was more important than the other. Therefore, any overall impact on an aspect given similar conditions is considered to have a similar effect as the other aspect in terms of weight. Socio-economic aspects were weighed at 34% for calculation purposes. Environmental audit data for the periods 2011, 2012 and 2013 were used.

Impacts are scored in a table based on the following scale;

3 Low and insignificant negative impact. Impacts are quite minimal and localized to a small extent. Mitigation measures can be implemented within three months. For the case of positive impacts, effect is notably high and visible, 100%, long-term and measurable.

2 Medium. Impact is reversible and quantifiable. Mitigation measures can be implemented within six months. For positive impacts, effect is 50% of the total.

1 Significant and high. Impact is quite expensive to correct, and difficult to quantify. It may pose externalities. Mitigation measures are long-term and results are noticeable after a year. For positive impacts, benefit is quite low, non-measurable and may even go un-noticed.

The weighed environmental aspect performance for each year is therefore calculated as;

$$Aspect\ performance\ (\%) = \frac{Impact\ score}{Impact\ weight} * Aspect\ weight\ \% \quad (1)$$

$$Total\ environmental\ performance\ (\%) = Physical\ performance\ (\%) + Biological\ performance\ (\%) + Socio-economic\ performance\ (\%) \quad (2)$$

The score and overall results are thereafter interpreted as percentage compliance or total environmental performance. This study also develops a grading compliance chart according to the scores;

80 – 100 %	Best and sustainable
60 – 80%	Good and sustainable
50 – 60%	Satisfactorily Good and sustainable
50%	Satisfactory and fairly sustainable
<50%	Poor and Project Improvement is needed, Un-sustainable.

Based on the findings, an improvement order is granted to some medium term impacts which are likely to pose long-term and negative environmental effects. In the case of positive effects, improvement orders may be given to strengthen key operation areas that will lead to sustainable development.

3.2 Results and Discussion

Table 1: Environmental Impact Score-card for the Menengai Geothermal drilling project

Aspect Weight	Aspect	Impact	KPI	Target		Impact Score			
					Impact Weight	2013	2012	2011	Improvement Order
33%	**Physical**	Solid Waste	Type of Waste generated	30% of plastic generated out of total waste	3	2	2	2	Yes Carefully dispose-off all plastics generated from operations appropriately and increase sensitization
		Liquid waste	Secured disposal/containment	100% containment/disposal	3	3	3	3	No
		Noise Emissions	Measured levels in decibels (dB A)	<85dB A	3	2	2	2	Yes Install high efficiency silencers
		Air Emissions (H_2S)	Measured atmospheric levels in ppm	<10ppm	3	2	2	2	No
		Soil erosion during site/road preparation and surface run-off	Constructed gabions and re-filling of gulleys with spoil	100% rehabilitation as required	3	2	2	1	Yes Reduce infrastructural works to only when necessary
		Oil Spills	Plans and procedures for proper storage and handling of oil and oil	100% Adherence to oil handling plans and procedures	3	2	2	2	No

			products						
		Visual/aesthetic value	Camouflage built infrastructure with the Environment	100% camouflaging. Paint all water pipelines to blend with the natural environment	3	3	3	3	No
		Score			***21***	***16***	***16***	***15***	
		Physical performance				***25.14%***	***25.14%***	***23.57%***	
33%	**Biological**	Faunal disturbance	Fauna studies to track faunal distribution	1 study per year	3	3	3	3	No
		Vegetation clearance	Afforestation of the project area	Raising, donation and planting of 60,000 seedlings per year	3	3	3	3	No
			Vegetation mapping studies	1 study per year	3	3	3	3	No
			% rehabilitated	100% rehabilitation after task completion	3	2	2	2	No
		Soil Chemistry	Soil quality	100% conformity to established standards	3	3	3	3	No
		Precipitation Chemistry	Rain water quality	100% conformity to established standards	3	3	3	3	No
		Borehole water Chemistry	Water quality	100% conformity to established standards	3	3	3	3	No
		Waste water chemistry	Waste water quality	100% containment/disposal	3	3	2	2	Yes, Enhance security to minimize vandalism of pond liners
		Score			***24***	***23***	***22***	***22***	
		Biological performance				***31.63%***	***30.25%***	***30.25%***	
34%	**Socio-economic**	Employment	Number of employee recruited (skilled + unskilled)	200 per year	3	3	3	2	No
		Tourism	Number of project visitors (groups)	5 groups per year	3	3	3	3	No
		Industrial accidents due to operations	Number of employees provided with	100% provision	3	3	2	2	Yes. Procure adequate PPE for all staff in

			appropriate PPEs						good time
		Energy Conservation	Energy saving bulbs	100% provision in all facilities	3	3	3	3	No
		Environmental Awareness	Number of employees sensitized	100 % sensitization	3	2	2	2	No
		Score			**15**	**14**	**13**	**12**	
		Socio-economic performance				***31.73%***	***29.46%***	***27.2%***	
		Total environmental performance				***88.5%***	***84.85%***	***81.02%***	

(Data: FOMEC, 2011; Simiyu et al. 2012; GDC, 2014)

Environmental performance for the Menengai geothermal project was above 80% and sustainable for all years. This was graded as '*Best and Sustainable Compliance',* and conforms to recommendations by NEMA, See appendix I.

Results indicate an increasing trend in the overall environmental performance for the Menengai Geothermal Project between the years 2011 and 2013 (Table 2).

Table 2: Summary Environmental Impact Score-card for the Menengai Geothermal drilling project

	Years and % Score			
Impact	**2011**	**2012**	**2013**	**% Total**
Physical	23.57	25.14	25.14	**73.85**
Biological	30.25	30.25	31.63	**92.13**
Socio-economic	27.2	29.46	31.73	**88.39**
% Total	**81.02**	**84.85**	**88.5**	

Impacts on the biological environment were far less than those on the physical environment. The indication is that even though monitoring of all aspects should continue, most environmental emphasis should be attributed to mitigation of environmental impacts related to the physical environment. These include advanced methods in soil erosion control, solid waste management and installation of high efficiency noise silencers during well-testing. The departments involved in these operations will be issued with improvement notices and will work in close association with the environmental experts towards mitigation. The increasing trend in environmental performance is explained by the increasing human and technical capacity over the years, more professional staffing levels and specialized training. In addition, the environmental experts have gained experience in environmental monitoring and have even engaged independent environmental conservationists such as the FOMEC with an interest in conservation of the Menengai Caldera to perform their own independent monthly environmental audits toward compliance and conservation of the Menengai Caldera. Even though the project scores very well, this should not reduce efforts toward environmental conservation within the Caldera. The proponent is expected to improve on key areas mentioned in Table 1 and the government and donor budget should continue in confidence to support further development of geothermal resources in Kenya.

4. RECOMMENDATIONS AND CONCLUSIONS

4.1 Recommendations

It is evident that the EMP for Menengai project has been implemented fully. However, the following improvement notices should be considered:

- Research and installation of high efficiency silencers at all discharging wells to minimize noise emissions.
- Clearing of vegetation should be done selectively, strictly controlled and limited to what is absolutely necessary. Environmental experts should be involved at all aspects of this operation and plans should be submitted prior to them for vegetation surveys and appropriate rehabilitation in the long run.
- Appropriate PPEs should be provided to all employees on time and enforcement/sensitization on proper use should be enhanced.
- Security of the Menengai project should be heightened, especially at the well sites to minimize vandalism of pond liners.
- Improvement notices issued to non compliant department/sections should strictly be adhered to and if possible, complying sections/departments should rewarded.
- Environmental awareness should be promoted to aid in attitude change among employees. Few individuals from other technical departments could be involved in environmental audits as a way of sensitization.

This systematic approach can also be applicable to other geothermal projects globally. The process is intended to raise environmental awareness, evaluate and improve environmental performance and compliance in geothermal development.

4.2 Conclusions

Successful implementation of the Menengai EMP has been enhanced by adherence to the existing Memorandum of Understanding between KFS and GDC and strict compliance to the applicable international and national legal regulatory frameworks. The project's environmental performance between the years 2011 and 2013 is above 80% with the '*best and sustainable compliance'* rating and has shown continuous improvement. Besides development in perspective, the project has maintained a sustainable environmental and social platform. It is therefore important for the proponent *'GDC'* to continue implementing and improving the EMP to the latter. The government and financiers are encouraged to continue supporting these types of projects toward attainment of Kenya's Vision 2030 and the UN Millennium Development goals.

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APPENDICES

Appendix 1: Compliance letter for the Menengai Geothermal Project, 2013

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

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GEOTHERMAL DEVELOPMENT CO. LTD
RECEIVED
20 MAR 2013
MANAGING DIRECTOR & CEO
P.O. Box 100746 - 00101, NAIROBI.

NEMA/EA/5/2/12,423

14th March, 2013

The Managing Director
Geothermal Development Company
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P.O. Box 100746-00101
NAIROBI

RE: COMPLIANCE LETTER

Following your response dated 14th February 2013, the National Environment Management Authority (NEMA) acknowledges the level of improvements that you have put in place.

You are hereby issued with a Compliance Letter. Ensure that you continue implementing the Environmental Management Plan as proposed.

ROBERT ORINA
For: DIRECTOR GENERAL

Our Environment, Our Life, Our Responsibilty

ISO 9001:2008 Certified